



This document includes the Section 7.0, Vessel, Aircraft, and Vehicle Refueling and Lubrication, of the Draft EPA "Weather Deck Runoff Characterization Analysis Report" published in 2003. The reference number is: EPA-842-D-06-006

# **DRAFT**

## **Characterization Analysis Report**

### **Weather Deck Runoff**

Section 7.0, Vessel, Aircraft, and Vehicle Refueling and  
Lubrication

2003

## **7.0 VESSEL, AIRCRAFT, AND VEHICLE REFUELING AND LUBRICATION**

Vessel, aircraft, and vehicle refueling and lubrication were assessed on CV/CVN, AOE 6, and LHD 1 Class vessels. Aircraft refueling can occur inside and outside 12 nm. Although spills are cleaned up, residual aircraft fuel (JP-5) may contribute to deck runoff. In addition to fuel, small amounts of general purpose cleaner, grease, and anti-seize compounds are used at the fueling stations. Fixed wing aircraft maintenance may contribute to deck runoff in the form of hydraulic fluid, and aircraft grease. Residual amounts of fuel, hydraulic fluid, grease, and anti-seize compounds may become trapped in the rough deck surface and subsequently contribute to deck runoff within 12 nm.

### **7.1 AIRCRAFT REFUELING**

Vessels that refuel aircraft are classified as either aviation vessels (e.g., aircraft carriers) or air capable vessels (e.g., destroyers and cutters). Armed Forces air capable vessels are listed in Operational Naval Instruction (OPNAVINST) 3120.35J (Navy, 2000) and range in size from 210 ft USCG medium endurance cutters (WMEC 210) to aircraft carriers (CV/CVN 68). Most aircraft refueling occurs while the aircraft are on deck. However, some vessel classes, such as the DDG 51, FFG 7, and WHEC 378 have helicopter in-flight refueling (HIFR) capabilities.

JP-5 jet fuel (MIL-DTL-5624T) is the only jet fuel authorized to be used aboard Navy vessels and carried by fleet oilers (Navy, 1996). JP-5 is a “middle distillate [,] specially blended kerosene”. It is characterized by “high concentrations of cycloalkanes and n-alkanes, lower concentrations of monoaromatics and branch alkanes, and very low concentration of benzene, toluene, ethylbenzene and xylenes (BTEXs) and polynuclear aromatic hydrocarbons (PAHs)” (Potter and Simmons, 1998).

Aircraft refueling activities can occur inside and outside 12 nm. Sources of JP-5 spills include aircraft tank vents, tank relief valves, and fueling station drains. On aircraft carriers (CVN and CV Classes), which are the vessels with largest number of aircraft (approximately 85 aircraft per carrier), approximately 20 gal of JP-5 spill during a 24 hr period of aircraft operation. On aircraft carriers, dedicated spill carts recover JP-5 from the deck, however, the efficiency of this recovery method has not been determined. JP-5 is not expected to remain on deck for long periods of time following aircraft refueling activities. Therefore, aircraft refueling activities are not likely to contribute significant amounts of JP-5 constituents to deck runoff (Wenzel *et al.*, 2001a).

#### **7.1.1 CV/CVN 68 Class Petroleum, Oil, and Lubricants**

For the CV/CVN Class, maintenance performed on refueling equipment located topside includes inspecting and lubricating hose reel assemblies, inspecting hose and nozzle assemblies, and lubricating the defueling pump (used for evacuating fuel hoses after fueling aircraft). The majority of fueling/defueling station maintenance is performed on equipment that is located below decks. Aircraft fueling stations are cleaned on a weekly basis using a cleaning compound (Spray & Wipe<sup>TM</sup>) and rags. Preservation is accomplished only during periods of repair

availability. Drains located in the fueling station discharge directly overboard as a fire safety measure (Wenzel *et al.*, 2001a).

The survey team did not notice any fuel spilled during the more than 20 aircraft fueling evolutions observed. However, the crew stated that an average of 20 gal of MIL-DTL-5624T jet fuel (JP-5) from aircraft tank vents and tank relief valves/dumps is spilled on the deck during a 24-hr period. A dedicated fuel spill cart is maintained on the flight deck to provide rapid spill response; the recovered fuel is transferred to the contaminated fuel tank. All fuel remaining in the fuel hose is evacuated prior to the release of the hose from the aircraft. Fuel that has spilled onto the deck from the tank vents and valves may become trapped in the rough deck surface and contribute to deck runoff within 12 nm (Wenzel *et al.*, 2001a).

The fueling stations are cleaned outside 12 nm after the departure of the air wing. Residual amounts of JP-5 spilled on the deck from the tank vents and valves may become trapped in the rough deck surface and subsequently contribute to deck runoff within 12 nm.

#### **7.1.2 LHD 1 Class Petroleum, Oil, and Lubricants**

For the LHD 1 Class, maintenance performed on topside equipment includes: lubricating the de-fueling pump; inspecting and lubricating the hose reel assemblies; and inspecting and lubricating the hose and nozzle assemblies. Most of the maintenance is performed on equipment located below decks and therefore does not contribute to deck runoff. Aircraft fueling stations are cleaned on a weekly basis using a cleaning compound (Spray & Wipe<sup>TM</sup>). Preservation of the aircraft fueling station equipment is accomplished during periods of repair availability (Wenzel *et al.*, 2001a).

Sources of JP-5 spills are aircraft tank vents and tank relief valves/dumps. The crew maintains a dedicated fuel spill cart on the flight deck to provide rapid spill response; the recovered fuel is transferred to the contaminated fuel tank. Drip pans are not used when fueling/defueling aircraft because they are a potential safety and equipment hazard. All fuel remaining in the fuel hose is evacuated prior to hose release from the aircraft. The survey team did not note any fuel spillage during the aircraft fueling evolutions observed. The fueling station drains discharge directly overboard (Wenzel *et al.*, 2001a).

The fueling station is cleaned outside 12 nm after the departure of the air wing. The drains are open when underway, and closed when the vessel is in port. Residual amounts of JP-5 spilled on the deck from the tank vents and valves may become trapped in the rough deck surface and subsequently contribute to deck runoff within 12 nm.

#### **7.1.3 AOE 6 Class Petroleum, Oil, and Lubricants**

The AOE 6 Class vessel's crew is responsible for performing all maintenance on the fueling station. After refueling an aircraft, the fueling hose is drained into a bucket, and the fuel is poured into the contaminated fuel tank. The survey team observed the aircraft refueling process several times and did not observe any spillage. Very small amounts of cleaning and lubricating materials are used on the aircraft fueling station, including: MIL-D-16791G general-purpose detergent; DOD-G-25408 grease, and anti-seize compound MIL-A-907. The AOE 6 Class vessels can carry 3 rotary wing aircraft (Federation of American Scientists, 1999). Although the survey team

concluded that aircraft refueling evolutions could contribute to deck runoff on CVN 68 Class vessels (carrying approximately 85 aircraft (Federation of American Scientists, 2000)), due to the small number of aircraft on the AOE 6, the survey team concluded that it did not have the potential to contribute to deck runoff generated by AOE 6 Class vessels. The survey team concluded that the refueling process on AOE 6 Class vessels did not have the potential to contribute to deck runoff (Wenzel *et al.*, 2001a).

#### 7.1.4 Summary of Petroleum, Oil, and Lubricants for Aircraft Refueling

CV/CVN 68 Class vessels spill approximately 20 gal of JP-5, MIL-DTL-5624T jet fuel daily. Aircraft fuel tank venting and malfunctioning equipment cause these spills. The crew immediately cleans up all spilled fuel. No spills were noted during the LHD 1 or AOE 6 shipboard assessments. It is important to note that all air operations occur outside 12 nm and the flight decks are thoroughly cleaned prior to transiting within 12 nm, with the exception of the AOE 6 class vessels. Because aircraft from the AOE 6 depart closer to shore than other aircraft, the final exterior topside surface washdown may occur within 12 nm. The potential does exist for trace amounts of fuel to be trapped in the rough non-skid deck surface to subsequently contribute to deck runoff within 12 nm.

**Table 7-1— Potential Discharge Materials for Aircraft Fueling**

Potential Discharge Material	Potential Discharge Volume (gal/fleet-yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet-yr)	Any BCCs Present?
Fuel, JP-5 MIL-DTL-5624T	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction

**Table 7-2—Narrative Parameters for Aircraft Fueling**

<b>Narrative Parameters</b>	<b>Survey Team Observations</b>
Alkalinity	Unknown-not evaluated
BOD/DO	Unknown-not evaluated
Colloidal Matter	Unknown-not evaluated
Color	Unknown-not evaluated
Floating Material	Potential exists
Hardness	Unknown-not evaluated
Nutrients	None
Odor	Unknown-not evaluated
Oil and Grease	Potential exists, none observed
Pathogens	None
PH	Unknown-not evaluated
Settleable Materials	Unknown-not evaluated
Specific Conductance	Unknown-not evaluated
Suspended Solids	Unknown-not evaluated
Taste	Unknown-not evaluated
Temperature	Would not change
Total Dissolved Gases	Unknown-not evaluated
Transparency	Unknown-not evaluated

The need for the information in this table was not recognized at the time of the assessment. The information is based on survey team recollection and consensus.

## **7.2 FIXED WING AIRCRAFT MAINTENANCE AND OPERATIONS**

Only the Navy aircraft carriers (CV and CVN Class designation) and amphibious assault vessels (LH 1 and LHA 1 Classes) carry fixed wing aircraft. Typical aircraft maintenance procedures that could produce deck runoff constituents include repairs to hydraulic lines and aircraft lubrication. Aircraft hydraulic fluid (MIL-PRF-83282D) contains more than 65 % of synthetic hydrocarbon base oil and less than 35 % of lubricant ester base. Aircraft grease (MIL-PRF-81322F) is mostly a complex mixture of paraffinic, naphthenic, and aromatic hydrocarbons. Although leaks and spills from hydraulic fluid lines and lubrication activities are immediately cleaned after detection, the possibility exists for trace amounts to remain on deck and contribute to deck runoff discharge.

### **7.2.1 CV/CVN 68 Class**

The survey team conducted a survey of the aviation support systems aboard a CV/CVN 68 Class vessel. The flight decks of aircraft carriers are large (> 4.5 acres), flat surfaces with a small (70 ft by 25 ft) island structure that houses the flight deck control tower, primary flight control, various bridges, and two auxiliary jet fuel stations. Unlike other vessels, the carrier flight deck has limited fixed topside equipment. Fixed equipment consists of arresting wires and barricade stanchions, jet blast deflectors, and catapult trough components. Most topside processes are performed using mobile equipment that is intermittently topside (e.g., aircraft, flight deck scrubber, and ground support equipment) (Wenzel *et al.*, 2001a).

Two C-2 aircraft that are not included in the vessel's air wing were also onboard the vessel daily. The C-2 Greyhounds are used for Carrier Onboard Delivery (COD) (i.e., transporting Navy and

## *DRAFT*

civilian personnel to an underway aircraft carrier). To safely perform aircraft operations and maintenance, a maximum of 48 – 52 aircraft are on the flight deck at one time, the remaining aircraft are housed in the hangar deck. Aircraft are normally flown-off the vessel at the end of a deployment when the vessel is 150 nm to 300 nm from land to provide vessel's crew time to conduct the flight deck washdown and subsequent staging of equipment for offload. Therefore, all processes that support aircraft operation are concluded before the vessel transits within 12 nm (Wenzel *et al.*, 2001a).

Aircraft embarked on CV/CVN 68 Class vessels are inspected and periodic maintenance/corrosion control is conducted on a 14- or 28-day [[edited for clarification for Navy]] cycle. Major maintenance actions are performed based on engine hours of operation. Leaks in the hydraulic lines are common; however, they are corrected as soon as they are detected. Depending on the weather conditions and location of the aircraft when the leak occurs, hydraulic fluid residue could contribute to deck runoff. All aircraft use MIL-PRF-83282D aircraft hydraulic fluid and MIL-PRF-81322F aircraft grease. Major maintenance actions performed on aircraft engines and airframes are conducted in the hangar bay located on the main deck (Wenzel *et al.*, 2001a).

### **7.2.2 LHD 1 Class**

The survey team conducted a survey of the aviation support systems aboard an LHD 1 Class vessel. The vessel carries five AV-8 Short Take-Off/Vertical Landing (STOVL) harrier aircraft operated and maintained by embarked Marine aviation combat element personnel. Aircraft are normally flown-off the vessel at the end of a deployment, thus providing the vessel's crew time to conduct flight deck washdown and subsequent staging of equipment for offload. All processes that support aircraft operation are concluded well before the vessel enters the 12 nm contiguous zone (Wenzel *et al.*, 2001a).

Aircraft embarked on LHD 1 Class vessels are inspected and periodic maintenance/corrosion control is performed on a 7-, 14-, or 28-day cycle. Major maintenance actions are performed based on engine hours of operation, typically in 25 hr to 50 hr cycles. Engine and airframe maintenance actions are performed in the hangar bay located on the main level, one level below the flight deck. Leaks in the hydraulic lines that contain MIL-PRF-83282D hydraulic fluid are common however the crew corrects the leaks immediately, contains the spill, blocks the scuppers, and cleans up the spill using absorbent pads and rags. The waste generated is containerized and sent to the HAZMINCEN for proper disposal (Surgeon, 2001; Wenzel *et al.*, 2001a). Depending on location of the aircraft when the leak occurs, hydraulic fluid residue could contribute to deck runoff.

### **7.2.3 Summary of Fixed Wing Aircraft Maintenance and Operations**

Fixed wing air operations are conducted aboard CV/CVN 68 and amphibious assault class vessels. The products that have the greatest potential to contribute to deck runoff are MIL-PRF-83282D aircraft hydraulic fluid and MIL-PRF-81322F aircraft grease. The data for these processes are shown below. Aircraft are normally flown-off the vessel at the end of a deployment to provide the ship's crew time to conduct the flight deck washdown and subsequent staging of

equipment for offload. Therefore, all processes that support aircraft operation are concluded well before the vessel enters within 12 nm.

**Table 7-3— Estimated Quantities of Discharge for Aircraft Operations, Fixed Wing**

<b>Aircraft Type</b>	<b>Engine Cleaning Frequency (hours of operation)</b>	<b>Hydraulic System Capacity (MIL-PRF-83282D)</b>
F-14	125	8 gal
F/A-18	150	4 gal
S-3	170	7.2 gal
EA-6B	150	7 gal
C-2	100	12 gal
E-2	100	12 gal
AV-8	Unknown	4 gal

**Table 7-4— Potential Discharge Materials for Aircraft Operations, Fixed Wing**

<b>Potential Discharge Material</b>	<b>Potential Discharge Volume (gal/fleet-yr)</b>	<b>Bulk Constituents</b>	<b>CAS #</b>	<b>Composition (%)</b>	<b>Constituent Mass Loading (gal/fleet-yr)</b>	<b>Any BCCs Present?</b>
Grease, MIL-PRF-81322F	Unknown	Mixture of paraffinic, naphthenic, and aromatic hydrocarbons	---	Unknown	Unknown	None
Hydraulic Fluid, MIL-PRF-83282D	Unknown	Synthetic hydrocarbon based oil	---	> 65	Unknown	None
		Ester based lubricant	---	< 35	Unknown	None

**Table 7-5—Narrative Parameters for Aircraft Operations, Fixed Wing**

<b>Narrative Criteria</b>	<b>Survey Team Observations</b>
Alkalinity	Unknown-not evaluated
BOD/DO	Unknown-not evaluated
Colloidal Matter	Unknown-not evaluated
Color	Unknown-not evaluated
Floating Material	Potential exists
Hardness	Unknown-not evaluated
Nutrients	None
Odor	Unknown-not evaluated
Oil and Grease	Potential exists, none observed
Pathogens	None
pH	Unknown-not evaluated
Settleable Materials	Unknown-not evaluated
Specific Conductance	Unknown-not evaluated
Suspended Solids	Unknown-not evaluated
Taste	Unknown-not evaluated
Temperature	Would not change
Total Dissolved Gases	Unknown-not evaluated
Turbidity/Colloidal Matter	Unknown-not evaluated

The need for the information in this table was not recognized at the time of the assessment. The information is based on survey team recollection and consensus.

### 7.3 FUEL TRANSFER SYSTEMS

Fuel transfer includes the supply of fuel to a vessel while pierside, fueling-at-sea (FAS) (See Figure 7-1), and the refueling and de-fueling of small boats onboard vessels. Underway refueling is performed outside 12 nm. In port refueling can be performed from either a permanent pier side fueling station, a floating fuel barge, or a pier side refueling truck. Three types of fuels are primarily used by Armed Forces vessels: (1) motor gasoline (MOGAS); (2) JP-5 (MIL-DTL-5624T); and (3) F-76 (MIL-F-16884J).

MOGAS is used to power spark ignition engines, predominantly found on outboard engines on small boats and combat vehicles. MOGAS is a low-end distillate with a high concentration of BTEX, monoaromatic (other than BTEX) and branched alkanes, lower concentration of n-alkanes, alkenes, cycloalkanes, and naphthalenes, and very low concentration of other PAHs (Potter and Simmons, 1998). Compensated MOGAS systems are installed on some amphibious vessels that require the transfer of large quantities of MOGAS for combat vehicles. Because of the low flash point and high risk of explosion from MOGAS, small quantities (e.g., used to supply small boats and craft) are stored in an outside fixed system described in NSTM Chapter 670, *Stowage, Handling, and Disposal of Hazardous General Use Consumables* (Navy, 1997c). The transfer of MOGAS between on deck systems and boats can occur anywhere inside or outside 12 nm. However, due to the extreme volatility of MOGAS and risk of vapor explosion, strict spill prevention and cleaning measures are in place (for details refer to NSTM Chapter 542, *Gasoline and JP-5 Fuel Systems* (Navy, 1997b)). Due to these spill prevention and cleaning measures, the amount of potential MOGAS constituents that may contribute to deck runoff is minimal and is limited to fuel residue.

In addition to its use as jet fuel for aircraft (see Section 2.61), JP-5 is used to power compression ignition engines of small boats and craft, and is an acceptable substitute for F-76 in vessel's compression ignition engines, gas turbines, and boilers. The transfer of JP-5 from on deck systems to boats can occur anywhere inside or outside 12 nm. The spill prevention and cleaning procedures outlined in NSTM 542 also apply to JP-5 spills, thereby limiting JP-5 contribution to deck runoff.

F-76, a type of kerosene distillate formerly known as diesel marine fuel (DMF), is the primary fuel used in Naval shipboard power plants including diesels, gas turbines, and boilers (Navy, 1996). Kerosene fuels are middle distillates with high concentrations of cycloalkanes and n-alkanes, lower concentrations of monoaromatics and branched alkanes, and very low concentrations of BTEXs and PAHs (Potter and Simmons, 1998). Traces amounts of F-76 may spill on the weather deck of a vessel during pierside fuel transfer operations or while fueling or de-fueling boats and craft powered by CI engines, and may contribute constituents to deck runoff discharges. However, FAS between vessels only occurs while underway outside 12 nm, and therefore it is not expected to contribute to deck runoff inside 12 nm.

**Figure 7-1. Fueling at Sea**



UNREP Fueling At Sea (FAS) Connection. Australian supply ship AOR 304 transfers 330,000 gal of fuel to U.S. Navy ship LHD 2. (Navy photograph by Stephanie M. Bergman.)

### **7.3.1 AOE 6 Class**

AOE 6 Class vessels have three receiving and two transfer stations on the starboard side and three transfer stations on the port side. The vessel receives fuel through its three starboard side fuel receiving stations when pierside and has a capacity to carry 6.5 million gal of fuel. AOE 6 Class vessels use the two fuel transfer stations on the starboard side, and three fuel transfer stations on the port side for conducting FAS operations. During FAS operations, MIL-F-16884J marine diesel fuel or MIL-DTL-5624T jet fuel (JP-5) is pumped from a delivery vessel to a receiving vessel. The topside equipment for each FAS station is independently operated and controlled. Each FAS station has five winches; three of the winches have 800 ft of 0.875 in wire rope, and two have 800 ft of 0.75 in wire rope. Each winch is greased with 5 gal of MIL-G-24139A general-purpose grease. In addition, each FAS station has three saddle winches that control the tension of the saddle whips. Each saddle winch has 400 ft of 0.5 in wire rope lubricated with 2.5 gal of MIL-G-24139A. Prior to refueling operations, plastic bags filled with oil absorbent material are double-bagged and placed in all topside scuppers to prevent an overboard discharge in the event of a spill. Upon completion of each fueling evolution, the fuel hose “nozzle” is placed in a large (38 in wide by 24 in deep) drip pan immediately after it is retrieved onboard. The drip pan remains in place until no fuel leakage is detected; the contents of the drip pan are then poured into the contaminated fuel tank. Some spillage during hose disconnect is normal. The amount spilled, approximately 3 gal to 5 gal, is difficult to assess precisely because circumstances vary for each operation and the quantity of the spillage will likewise vary depending on these circumstances. The vessel’s crew ensures that no contaminants go overboard during FAS operations. One member of each FAS crew stands by during operations to clean up excess grease that drops from the wire rope to the weather deck. Although underway replenishment operations are conducted outside the contiguous zone, the potential does exist for the wire rope grease to be washed off during rainfall within 12 nm; therefore, MIL-G-24139A general purpose grease has the potential to contribute to deck runoff (Wenzel *et al.*, 2001a).

### **7.3.2 DDG 51 Class**

DDG 51 Class vessels have four refueling stations, that are not enclosed by a containment device. All fuel pumps and control systems are located below deck. In addition to locating the spill kit close to the refueling station, the crew takes the following precautions to prevent fuel from entering surrounding waters: (1) plastic bags are filled with water and placed in scupper drains during refueling operations, and (2) buckets are placed under hose connection points during refueling operations. However, residual contaminants resulting from refueling operations have the potential to contribute to deck runoff in the event of a significant spill or if the crew does not take precautionary measures (Wenzel, 2000b).

### **7.3.3 MCM 1 Class**

MCM 1 Class vessels normally receive fuel from a shoreside refueling truck while the vessel is pierside. All fuel transfer pumping gear is located below decks and is common to both amidships (one port, one starboard) refueling stations. Above-deck valves and piping are enclosed within a containment device. The crew takes the following precautions to prevent fuel from entering surrounding waters: (1) threaded plugs are installed in the containment device to allow the controlled drainage of collected rainfall or fuel in the event of a leak; (2) an oil boom is placed around the vessel; (3) all deck drains are plugged during refueling operations; and (4) a spill kit is

maintained onboard. Because the vessel does not carry or maintain fueling hoses onboard, the shoreside fuel depot provides equipment (fuel hoses equipped with cam lock quick disconnect fittings) required for refueling operations. As a result of the above measures, there is minimal potential for the fuel transfer system to contribute to deck runoff in the form of fuel residue trapped in the rough deck surface. A potential for spillage exists only when connecting or disconnecting the transfer hoses (Wenzel, 2000c).

#### **7.3.4 WLM 175 Class**

WLM 175 Class vessels are typically fueled from their operating pier via hoses. These vessels have the capability of transferring fuel from their storage tanks to other vessels. However, due to the vessels' operational zone, this capability has not been used to date. All fuel transfer pumping gear is located below decks, with the above deck valves and piping located in a container. The potential to contribute to deck runoff exists only when the residue from an inadvertent diesel fuel spill (when connecting or disconnecting the transfer hoses) becomes trapped in the rough deck surface (Wenzel, 2000a).

#### **7.3.5 WPB 110 Class**

WPB 110 Class vessels are typically fueled through hoses from a refueling truck while the vessel is pierside. Refueling stations are located on the forward section of the vessel's superstructure, both port and starboard. All fuel transfer pumping gear is located below deck and is common to both refueling stations, with the above-deck valves and piping located in a containment enclosure. The refueling stations are covered with canvas zip-down covers secured to the vessel with snaps to protect the equipment from the elements. In addition, the crew installed threaded plugs in the containment enclosure. During refueling evolutions, an oil boom is placed around the vessel and all deck drains are plugged. The area around the refueling station is lined with sandbags to assist in containment in the event of an accidental spill. The fuel depot personnel maintain spill kits on the pier. The potential to contribute to deck runoff exists when the residue from an inadvertent diesel fuel spill (when connecting or disconnecting the transfer hoses) becomes trapped in the rough deck surface (Wenzel, 2000d).

#### **7.3.6 Summary of Petroleum, Oil, and Lubricants for Fuel Transfer Systems**

The type of fuel transfer systems used on the vessels assessed varied in complexity and size. The fuel transfer system on AOE 6 Class vessels has the potential to contribute to deck runoff. The AOE 6 Class vessel has five very large stations used for fueling-at-sea (FAS) operations. Each station uses winch engines, wire rope, cable drums with sheaves, and control systems required to conduct refueling at sea operations. The potential to contribute to deck runoff does exist when residual fuel from an inadvertent spill becomes trapped in the rough deck surface during a DDG 51 fueling evolution; however, the potential is minimal and the crew exercises measures to prevent the spill from entering surrounding waters. The MCM 1, WLM 175, and WPB 110 are fueled from the pier and have containment structures surrounding the fuel receiving stations. The other vessels surveyed had receiving stations for fuel transfer and, as a general rule, do not transfer fuel to other vessels (Wenzel *et al.*, 2001a).

**Table 7-6— Estimated Quantities of Fuel Transfer Systems Discharges**

Vessel Class	Equipment	Potential Discharge Material	Amount Used
AOE 6	2400 ft 0.875 in wire rope	Grease, MIL-G-24139A	15 gal
AOE 6	1600 ft 0.75 in wire rope	Grease, MIL-G-24139A	10 gal
AOE 6	1200 ft 0.5 in wire rope	Grease, MIL-G-24139A	7.5 gal

**Table 7-7— Potential Discharge Materials for Fuel Transfer Systems**

Potential Discharge Material	Potential Discharge Volume (gal/fleet-yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet-yr)	Any BCCs Present?
Multipurpose Grease, MIL-G-24139A	Unknown	Petroleum hydrocarbons	---	Unknown	Unknown	Unknown
Fuel, JP-5 MIL-DTL-5624T	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction
Fuel, F-76 MIL-F-16884J	Unknown	Kerosene	8008206	Unknown	Unknown	Unknown
MOGAS ASTM D4814	Unknown	Gasoline	8006619	100	Unknown	Unknown

**Table 7-8—Narrative Parameters for Fuel Transfer Systems**

<b>Narrative Parameters</b>	<b>Survey Team Observations</b>
Alkalinity	Unknown-not evaluated
BOD/DO	Unknown-not evaluated
Colloidal Matter	Unknown-not evaluated
Color	Unknown-not evaluated
Floating Material	Potential exists
Hardness	Unknown-not evaluated
Nutrients	None
Odor	Unknown-not evaluated
Oil and Grease	Potential exists, none observed
PH	Unknown-not evaluated
Pathogens	None
Settleable Materials	Unknown-not evaluated
Specific Conductance	Unknown-not evaluated
Suspended Solids	Unknown-not evaluated
Taste	Unknown-not evaluated
Temperature	Would not change
Total Dissolved Gases	Unknown-not evaluated
Turbidity/Colloidal Matter	Unknown-not evaluated

Note: At the time of the assessment, the need for the information in this table was not identified. The information is based on survey team recollection and consensus.

## **7.4 GROUND SUPPORT EQUIPMENT**

CV/CVN 68 Class vessels and amphibious assault vessel classes (LHD) use ground support equipment (GSE) to maintain and move aircraft on the flight deck. The equipment uses several types of lubricants and greases that have the potential to leak and present a potential contributor to deck runoff. Although lubricants may leak from the equipment, they are cleaned up immediately, if and when they are detected. However, some maintenance materials may become trapped in the rough deck surface and enter surrounding waters within the contiguous zone, including oil, transmission fluid, hydraulic fluid, and antifreeze (Wenzel *et al.*, 2001a).

### **7.4.1 AOE 6 Class**

Minimal GSE is required to support aircraft operations onboard this vessel class. The GSE includes: one hydraulic service unit, 4 aircraft hydraulic jacks, one portable hydraulic test stand, and one nitrogen oxide cart. The GSE is inspected daily for proper operation (Wenzel *et al.*, 2001a).

### **7.4.2 CV/CVN Class**

Ground support equipment is comprised of vehicles and associated machinery to move, start, and load aircraft. This equipment is found primarily on large aviation and air capable vessels (e.g., CVN and LHD Class designation). Incidental leaks of hydraulic fluid (MIL-PRF-83282D) and engine oil (MIL-L-2104G) are the main deck runoff constituent sources from this equipment. Although leaks and spills are immediately cleaned if and when detected, the possibility exists for trace amounts to remain on deck and contribute to deck runoff discharge. However, some

maintenance materials may become trapped in the rough deck surface and enter surrounding waters within the contiguous zone during a rainfall event including: SAE J2362 oil, Dextron II or III automatic transmission fluid, MIL-PRF-83282D hydraulic fluid, MIL-L-17331H hydraulic fluid, and AA-52624 antifreeze (Wenzel *et al.*, 2001a).

Ground Support Equipment (GSE) carried onboard the CV/CVN Class vessel is illustrated in the following table.

**Table 7-9— Ground Support Equipment, CV/CVN Classes**

Equipment	Quantity
Mobile electric power plant	1
Gas turbine engine enclosure	1
Flight deck scrubber	1
Hydraulic servicing cart	1
Hydraulic power supplies	3
Maintenance stands	2
Aircraft jacks	3
Weapons loading hoist	1
Aircraft towing tractors	10
Crash and salvage crane*	1
Forklifts*	2
Flight deck fire trucks	1
Coolant oil servicing cart	1

\*Also listed in Fire Assist Vehicle report section

The equipment listed in Table 7-9 was not all on the flight deck at one time. The amount of equipment topside was dependent on equipment availability and operational requirements.

#### **7.4.3 LHD 1 Class**

The LHD 1 Class vessel had the following equipment: four tow tractors, one tow tractor unit, four 6,000 lb. Forklifts, one 20,000 lb. crash crane, two pressure washers, one nitrogen oxide cart, one hydraulic service unit, one mobile electric power plant, one corrosion control cart, and one flight deck scrubber. This equipment was not all on the flight deck at one time; the amount of equipment topside was dependent on equipment availability and operational requirements (Wenzel *et al.*, 2001a).

Although lubricants may leak from the equipment, they are cleaned up as soon as they are detected. However, some maintenance materials may become trapped in the rough deck surface enter surrounding waters within the contiguous zone during a rainfall event including: MIL-PRF-2104G lubricating oil, MIL-PRF-2105E lubricating oil, MIL-PRF-83282D hydraulic fluid, A-A-52624A antifreeze, MIL-DTL-17111C power transmission fluid, and Dextron III automatic transmission fluid (no Military Specification) (Wenzel *et al.*, 2001a).

#### **7.4.4 U.S. Army Vessels**

JP-8 (very similar in chemical composition to JP-5 but with a larger range of alkanes) is used to power various cargo (e.g., Humvees and tanks) on Army vessels (U.S. Army, 1997; Potter & Simmons, 1998). This cargo may be stored above or below decks. The transfer of JP-8 from on deck systems to cargo is unlikely to occur while on the vessel. However, occasionally cargo may leak trace amounts of JP-8 on to the weather deck. Although spills are immediately cleaned up, some fuel may remain trapped in the rough deck surface and has the potential to contribute to deck runoff (Arredondo, 2001).

#### **7.4.5 Summary of Petroleum, Oil, and Lubricants for Ground Support Equipment**

CV/CVN 68 Class vessels and amphibious assault vessel classes use ground support equipment to maintain and move aircraft on the flight deck. The equipment uses several types of lubricants and greases that have the potential to leak and present a potential contributor to deck runoff (Wenzel *et al.*, 2001a).

The survey team was unable to quantify the amount of material that has the potential to leak from the equipment and enter surrounding waters.

Table 7-10— Potential Discharge Materials for Ground Support Equipment

Potential Discharge Material	Potential Discharge Volume (gal/fleet-yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet-yr)	Any BCCs Present?
Fuel, JP-5 MIL-DTL-5624T	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction
Motor oil SAE J2362	Unknown	Petroleum oils	---	Unknown	Unknown	Unknown
Hydraulic Fluid MIL-PRF-83282D	Unknown	Synthetic hydrocarbon based oil	---	> 65	Unknown	Unknown
		Ester based lubricant	---	< 35	Unknown	Unknown
Lubricating oil MIL-L-17331H	Unknown	Unknown	---	Unknown	Unknown	Unknown
Antifreeze A-A-52624A	Unknown	Propylene glycol	57556	Unknown	Unknown	None
Power transmission fluid, MIL-DTL-17111C	Unknown	Synthetic hydrocarbon	—	< 75	Unknown	Unknown
		Methacrylate polymers	—	< 25	Unknown	Unknown
		Tricresyl phosphate	—	< 1	Unknown	Unknown
Lubricating Oil, MIL-PRF-2104G	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Lubricating Oil, MIL-PRF-2105E	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Dextron Automatic Transmission Fluid Type II or III 9150-00-657-4959	Unknown	Highly refined base oils	—	> 85	Unknown	Unknown
		Additives	—	< 15	Unknown	Unknown
Fuel, JP-8 MIL-DTL-83133E	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction

**Table 7-11— Narrative Parameters for Ground Support Equipment**

<b>Narrative Parameters</b>	<b>Survey Team Observations</b>
Alkalinity	Unknown-not evaluated
BOD/DO	Unknown-not evaluated
Colloidal Matter	Unknown-not evaluated
Color	Unknown-not evaluated
Floating Material	Potential exists
Nuisance Species	Unknown-not evaluated
Nutrients	None
Odor	Unknown-not evaluated
Oil and Grease	Potential exists, none observed
Pathogens	None
pH	Unknown-not evaluated
Settleable Materials	Unknown-not evaluated
Specific Conductance	Unknown-not evaluated
Suspended Solids	Unknown-not evaluated
Taste	Unknown-not evaluated
Temperature	Would not change
Total Dissolved Gases	Unknown-not evaluated
Turbidity/Colloidal Matter	Unknown-not evaluated

The need for the information in this table was not recognized at the time of the assessment. The information is based on survey team recollection and consensus.

## **7.5 ROTARY WING AIRCRAFT MAINTENANCE AND OPERATIONS**

Rotary wing aircraft operate from aviation and air capable vessels that range from large aircraft carriers to USCG medium endurance cutters (WMEC 210 Class). Most rotary wing operations from Navy vessels occur outside 12 nm; with training operations occurring inside 12 nm. USCG vessels routinely operate rotary wing aircraft inside and outside 12 nm.

The rotary wing aircraft operation procedure that could produce deck runoff constituents is repairs to hydraulic lines. The aircraft hydraulic fluid used in rotary wing aircraft (MIL-PRF-83282D) contains more than 65 % of synthetic hydrocarbon base oil and less than 35 % of lubricant ester base. Although any hydraulic fluid that spills on deck is immediately cleaned, constituents may be entrained with deck runoff discharges inside 12 nm.

### **7.5.1 AOE 6 Class**

The survey team conducted a survey of the aviation support systems aboard an AOE 6 Class vessel. The vessel carries two CH-46 helicopters operated and maintained by squadron personnel assigned to the vessel during underway periods. The helicopter's primary mission is to transport cargo and personnel; its secondary mission is to perform search and rescue operations (Wenzel, 2000e). All aircraft usually disembark prior to entering within 12 nm; however, final deck cleaning and aircraft maintenance operations are sometimes conducted within the 12 nm zone. The following maintenance activities are performed on aircraft.

- The struts of the aircraft are greased every 7 days or 24 hours of flight operations using MIL-PRF-81322F.

- All access doors are greased every 56 days using MIL-PRF-81322F; however, if the aircraft are frequently deployed, the access doors are greased every 14 days.
- Rotor heads are greased every 7 days or 24 hours of flight operations using MIL-PRF-23827C.
- The engine oil, MIL-PRF-23699F, is changed every 100 hr of flight operations.
- The hydraulic system for the aircraft's flight controls is inspected for contamination every 400 hr of flight operations. The flight control system uses aircraft hydraulic fluid MIL-PRF-83282D.
- The search and rescue winch, which uses MIL-PRF-83282D hydraulic fluid, is inspected daily prior to each flight (Wenzel, 2000e).

#### **7.5.2 CV/CVN 68 Class**

For the CV/CVN 68 Class, seven SH-60 Seahawk helicopters carried onboard the vessel are operated and maintained by squadron personnel (Wenzel *et al.*, 2001b). All aircraft disembark prior to entering the contiguous zone. As a result, discharges generated during aircraft cleaning and maintenance not conducted on the vessel are not subject to uniform national discharge standards.

The helicopters are inspected and periodic maintenance/corrosion control is conducted on a 14- or 28-day cycle. Major maintenance actions are performed based on engine hours of operations. All scheduled maintenance actions are performed in the hangar bay below the main deck and therefore these processes do not contribute to deck runoff. The SH-60 helicopter uses MIL-PRF-83282D aircraft hydraulic fluid (Wenzel *et al.*, 2001b).

#### **7.5.3 DDG 51 Class**

The survey team conducted a survey of the aviation support systems aboard a pierside DDG 51 Class vessel. Rotary wing aircraft embark and disembark DDG 51 Class vessels when the vessel is outside 12 nm. Because the assessment was conducted pierside, air wing personnel were not aboard the vessel and the survey team was unable to gather specific information on air operations from this vessel class (Wenzel *et al.*, 2001a). However, because of the similar nature of rotary wing operations between vessel classes, similar constituents are expected to that of other vessels that conduct rotary wing air operations.

#### **7.5.4 LHD 1 Class**

LHD 1 Class vessel had 24 rotary wing aircraft onboard during the survey team assessment: four CH-53 Sea Stallions; four AH-1 Sea Cobras; two UH-1 Hueys; and fourteen CH-46 Sea Knights. All of the aircraft, except two CH-46 helicopters, are operated and maintained by embarked Marine aviation combat element personnel (Wenzel *et al.*, 2001c).

The helicopters are inspected and periodic maintenance/corrosion control is based on engine hours of operation in addition to a 7-, 14-, or 28-day cycle. Major maintenance actions are performed in the hangar bay below the main deck and therefore these processes do not contribute to deck runoff. As with fixed wing aircraft, leaks in the hydraulic lines of rotary wing aircraft are common and are corrected as soon as they are detected (Wenzel *et al.*, 2001c).

### 7.5.5 Summary of Rotary Wing Aircraft Maintenance and Operations

Rotary wing air operations are conducted aboard a number of Navy and USCG vessels. The materials that have the greatest potential to contribute to deck runoff are MIL-PRF-81322F grease, MIL-PRF-83282D aircraft hydraulic fluid, MIL-PRF-23827C grease, and MIL-PRF-23699F engine oil. The data for these materials are shown below. As was previously noted, aircraft are normally flown-off the vessel at the end of a deployment when the vessel is well outside of the 12 nm zone to provide vessels' crew time to conduct the flight deck washdown and subsequent staging of equipment for offload.

**Table 7-12— Potential Discharge Materials for Aircraft Operations, Rotary Wing**

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Grease, MIL-PRF-81322F	Unknown	Mixture of paraffinic, naphthenic, and aromatic hydrocarbons	—	Unknown	Unknown	Unknown
Hydraulic Fluid, MIL-PRF-83282D	Unknown	synthetic hydrocarbon based oil	—	> 65	Unknown	Unknown
		Ester based lubricant	—	< 35	Unknown	Unknown
Grease, MIL-PRF-23827C	Unknown	synthetic ester	—	75 - 85	Unknown	None
		Lithium 12 hydroxystearate	7620771	10 - 15	Unknown	None
		Antimony dialkyldithiocarbamate	15890252	1-2	Unknown	None
		p,p'-Diocetyldiphenylamine	101677	1	Unknown	None
Engine Oil, MIL-PRF-23699F	Unknown	Polyol ester	68424317	0 - 90	Unknown	None
		Synthetic ester/fatty acids	68424339	0 - 90	Unknown	None
		Octylated N-phenyl-1-naphthylamine	68259369	< 2	Unknown	None
		p,p'-Diocetyldiphenylamine	101677	< 2	Unknown	None
		Tricresylphosphate (mixed)	1330785	1	Unknown	None

**Table 7-13—Narrative Parameters for Aircraft Operations, Rotary Wing**

<b>Narrative Parameters</b>	<b>Survey Team Observations</b>
Alkalinity	Unknown-not evaluated
BOD/DO	Unknown-not evaluated
Color	Unknown-not evaluated
Floating Material	Potential exists
Hardness	Unknown-not evaluated
Nutrients	None
Odor	Unknown-not evaluated
Oil and Grease	Potential exists, none observed
pH	Unknown-not evaluated
Pathogens	None
Settleable Materials	Unknown-not evaluated
Specific Conductance	Unknown-not evaluated
Suspended Solids	Unknown-not evaluated
Taste	Unknown-not evaluated
Temperature	Would not change
Total Dissolved Gases	Unknown-not evaluated
Turbidity/Colloidal Matter	Unknown-not evaluated

The need for the information in this table was not recognized at the time of the assessment. The information is based on survey team recollection and consensus.

## **7.6 PERFORMANCE OBJECTIVE AND ACTIVITIES**

The objective for vessel, aircraft, and vehicle refueling is for the vessel's responsible party to prevent the discharge of anti-freeze compounds, fuels, hydraulic fluids, oils, greases, and other materials associated with vessel, aircraft, and vehicle refueling and lubrication that may negatively impact water quality. Activities that could be performed to meet this performance objective include, but are not limited to: minimizing vessel, aircraft, and vehicle refueling within 12 nm; and performing hose blowdown or applying back suction to drain the hose.

Depending on the vessel's mission operational area, vessels, aircraft, and vehicles may be refueled both inside and outside 12 nm. Although decks are immediately cleaned after spills, some fuel may remain trapped in the rough deck surface and contribute to deck runoff both inside and outside 12 nm. If a vessel, aircraft, or vehicle were refueled outside 12 nm, the amount of constituents on the deck that could contribute to deck runoff inside 12 nm would be reduced because most of any spilled fuel would be cleaned from the deck before the vessel is within 12 nm.

A hose blowdown occurs after the refueling is complete and the ship's fuel tank is secured from the aircraft. When performing a hose blowdown, the valve from the tank is closed and the remaining fuel is pumped to the aircraft, emptying all fuel from the hose. Back suction takes place when the fueling is complete; the transfer pump is reversed, and all fuel left in the hose is pumped into the shipboard fuel holding tank. Both of these methods prevent fuel from spilling on the deck, therefore reducing the amount of JP-5 contributing to deck runoff through hose disconnect spillage.

## *DRAFT*

USCG vessels do not have the capability to perform a hose blowdown. However, USCG vessels use self-closing aircraft refueling nozzles that prevent the spillage of fuel. This type of nozzle locks into a corresponding receptacle on the aircraft. Different types of aircraft typically have different style refueling receptacles or fill ports. Because USCG vessels only carry two types of aircraft (HH-65 & HH-60), the use of an aircraft specific self-closing aircraft refueling nozzle is possible.